

**TRANSMITTAL OF APPEAL BRIEF**Docket No.  
33226/936001; P8316

In re Application of: Alexander T. Garthwaite

Application No.  
10/679,559-Conf. #3291Filing Date  
October 6, 2003Examiner  
J. R. GoldenGroup Art Unit  
2187Invention: CONCURRENT INCREMENTAL GARBAGE COLLECTOR WITH A CARD TABLE  
SUMMARIZING MODIFIED REFERENCE LOCATIONS**TO THE COMMISSIONER OF PATENTS:**Transmitted herewith is the Appeal Brief in this application, with respect to the Notice of Appeal  
filed: June 7, 2007 .

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/Robert P. Lord/

Dated: December 3, 2007

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Docket No.: 33226/936001; P8316  
(PATENT)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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In re Patent Application of:  
Alexander T. Garthwaite

Confirmation No.: 3291

Application No.: 10/679,559

Art Unit: 2187

Filed: October 6, 2003

Examiner: J. R. Golden

For: CONCURRENT NON-INTRUSIVE  
PROCESSING OF A CARD TABLE  
SUMMARIZING MODIFIED REFERENCE  
LOCATIONS

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MS Appeal Brief – Patents  
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**APPELLANTS' BRIEF UNDER 37 C.F.R. § 41.37**

Pursuant to 37 C.F.R. § 41.37, please consider Appellant's Brief in the referenced application currently before the Board of Patent Appeals and Interferences. The fees required under § 41.20(b)(2) are dealt with in the accompanying Transmittal of Appeal Brief.

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**I. Real Party in Interest**

The real party in interest is Sun Microsystems, Inc., the assignee of record for the referenced application. An Assignment dated October 3, 2003, according to which the inventor transferred all interest in the referenced application, was filed by the USPTO on October 6, 2003. The Assignment is recorded at Reel 014589, Frame 0166.

**II. Related Appeals and Interferences**

To the best of Appellant's and its legal representative's knowledge, there are no related appeals or interferences that may directly affect, be affected by, or have a bearing on the Board's decision in the pending appeal.

**III. Status of Claims**

Application Serial No. 10/679,559 (the "'559 Application") was filed on October 6, 2003. As filed, the '559 Application included claims 1-28. In a Response to Office Action dated November 7, 2006, claims 1, 6, 8, 10, 11, and 22- 24 were amended, and claims 15-21 were canceled. Currently, claims 1-14 and 22-28 are pending. Claims 1, 8, and 22 are independent. The remaining claims depend, either directly or indirectly, from claims 1, 8, and 22.

All of the pending claims were finally rejected under 35 USC § 112, first paragraph, in a Final Office Action dated February 7, 2007 ("Final Office Action"). Additionally, the Examiner objected to the drawings under 37 CFR § 1.83(a). An Early Response to the Final Office Action was filed on March 30, 2007. The Examiner's findings were sustained in an Advisory Action dated April 12, 2007. A Notice of Appeal and Pre-Appeal Brief were filed on June 7, 2007. In response,

the Notice of Panel Decision from Pre-Appeal Brief Review, dated November 2, 2007, directed Appellant to proceed to the Board of Patent Appeals and Interferences.

Claims 1-14 and 22-28 are on appeal.

#### **IV. Status of Amendments**

All of the amendments have been entered and considered by the Examiner. No amendments have been filed subsequent to the Final Office Action. The claims of record are presented in the Claims Appendix.

#### **V. Summary of Claimed Subject Matter**

Independent claim 1 relates to a method for memory reclamation involving tracking and summarizing modified references in a garbage collector operating with other applications. The method includes a generation that is partitioned into a group of memory sections which, if one or more of the memory sections has been written into or dirtied by an application, are associated with card table indicators. The method involves (i) finding indicators and using atomic interrogation to determine if any have been dirtied; (ii) resetting the dirty indicator to indicate not dirtied; (iii) scanning the dirtied memory section and updating the indicators or remembered sets of corresponding objects by storing, in the indicators or remembered sets, a location of objects that reference the corresponding objects; and (iv) atomically interrogating the indicators again and, if none are dirty, moving on to collect a next scheduled group of memory sections, or if an indicator is dirty, preserving the indicators as just interrogated before moving on to another group of memory sections distant from the next scheduled group. The method described in independent claim 1 is

described in at least pages 21-25, and 33-37 and Figures 8A, 9, 12A-12J, 13A, and 18-20 of the '559 Application as filed.

Independent claim 8 relates to a computer system for memory reclamation involving tracking and summarizing modified references in a garbage collector operating with other applications. The system includes a generation that is partitioned into a group of memory sections which, if one or more of the memory sections has been written into or dirtied by an application, are associated with card table indicators. The system further includes a means to (i) find indicators and atomically interrogate them to determine if any have been dirtied; (ii) reset the dirty indicator to indicate not dirtied; (iii) scan the dirtied memory section and update the indicators or remembered sets of corresponding objects by storing, in the indicators or remembered sets, a location of objects that reference the corresponding objects; and (iv) atomically interrogate the indicators again and, if none are dirty, moving on to collect a next scheduled group of memory sections, or if an indicator is dirty, preserve the indicators as just interrogated before moving on to another group of memory sections distant from the next scheduled group. The system described in independent claim 8 is described in at least pages 21-25, and 33-37 and Figures 8A, 9, 12A-12J, 13A, and 18-20 of the '559 Application as filed.

Independent claim 22 relates to a computer readable media. The media contains instructions for executing a method for memory reclamation involving tracking and summarizing modified references in a garbage collector operating with other applications. The method includes a generation that is partitioned into a group of memory sections which, if one or more of the memory sections has been written into or dirtied by an application, are associated with card table indicators. The method involves (i) finding indicators and using atomic interrogation to determine if any have

been dirtied; (ii) resetting the dirty indicator to indicate not dirtied; (iii) scanning the dirtied memory section and updating the indicators or remembered sets of corresponding objects by storing, in the indicators or remembered sets, a location of objects that reference the corresponding objects; and (iv) atomically interrogating the indicators again and, if none are dirty, moving on to collect a next scheduled group of memory sections, or if an indicator is dirty, preserving the indicators as just interrogated before moving on to another group of memory sections distant from the next scheduled group. The media described in independent claim 22 is described in at least 21-25, and 33-37 and Figures 8A, 9, 12A-12J, 13A, and 18-20 of the '559 Application as filed.

## **VI. Grounds of Rejection to be Reviewed on Appeal**

The present Appeal addresses the following grounds of rejection:

- Whether claims 1-14 and 22-28 are patentable under 35 U.S.C. § 112, first paragraph, as complying with the written description requirement with regard to the limitation that “objects which have their references updated correspond to a dirtied memory section.”
- Whether claims 1-14 and 22-28 are patentable under 35 U.S.C. § 112, first paragraph, as complying with the written description requirement with regard to the limitation “storing at least one location of referencing objects in the card table indicators.”

## **VII. Argument**

### **A. Claims 1-14 and 22-28 Comply With the Written Description Requirement of 35 U.S.C. § 112, First Paragraph**

The status of the claims involved in this action is described in detail in Section III above.

The Examiner's rejection under 35 U.S.C. § 112, first paragraph, arose in response to Appellant's



amendments submitted in a Response to a Non-Final Office Action dated June 7, 2006 (hereafter "Response"). In the Response, Appellant amended independent claims 1, 8, and 22 to recite the limitation "wherein updating the card table indicators or remembered sets of corresponding objects comprises storing, in the card table indicators or remembered sets, at least one location of referencing objects that reference the corresponding objects." (Response, p. 5). In the resulting Final Office Action, the Examiner asserted that the Specification did not teach "storing a reference of at least one location of referencing objects that reference the corresponding object when updating the card table indicators or remembered sets of objects corresponding to a dirtied memory section," (emphasis in original) nor was there was any mention of "storing a location of referencing objects in the card table indicators." (Final Office Action, dated February 7, 2007, p. 4)

In the after-final response filed on March 30, 2007, the Appellant addressed the Examiner's rejection under 35 U.S.C. § 112, by specifically indicating the locations in the specification which supported the claim amendments present in the Response. (After-Final Response, pp. 4-6).

In the subsequent Advisory Opinion the Examiner stated that he was not aware of any portion of the Specification that taught that the card table indicators or remembered sets have a location of at least one location of referencing objects stored therein when they are updated. (Advisory Opinion, dated April 18, 2007, p. 2). Appellant respectfully disagrees with this position.

When asserting lack of written description under 35 U.S.C. § 112, first paragraph, the Examiner bears the burden of presenting a prima facie case of unpatentability. A description as filed is presumed to be adequate, unless or until the Examiner demonstrates, by a preponderance of evidence, that a person skilled in the art would not recognize the claimed invention in the

applicant's disclosure. MPEP 2163.04; *Kyoto Manufacturing Co., Ltd. V. Turn-Key-Tech, LLC*, 381 F.3d 1142, 1154 (Fed. Cir. 2004). To overcome a prima facie case, an applicant must show that the invention as claimed is adequately described. *In re Alton*, 76 F.3d 1168 (Fed. Cir. 1996).

The failure of a specification to specifically mention a limitation that later appears in the claims is not fatal if one skilled in the art would recognize that the new language reflects what the specification shows. *All Dental Prodx, LLC v. DMG*, 309 F.3d 774, 779 (Fed. Cir. 2002). The subject matter of the claim need not be described explicitly or *in haec verba*. MPEP §2163.02; *Ex parte Holt*, 19 USPQ2d 1211 (BPAI 1991); *Eiselstein v. Frank*, 52 F.3d 1035, 1038 (Fed. Cir. 1995). If the earlier application shows the subject matter that is later claimed with adequate direction as to how to obtain it, an invention may be described in different ways and still be the same invention. *Kennecott Corp. v. Kyocera Int'l, Inc.*, 853 F.2d 1419, 1422 (Fed. Cir. 1987). There are no strict formalities regarding adequate direction-- it may be an express, implicit or inherent disclosure consisting of "words, structures, figures, diagrams, formulas, etc." *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1572 (Fed. Cir. 1997); MPEP §2163. The test for sufficiency of support is whether the disclosure relied upon "reasonably conveys to the artisan that the inventor had possession at that time of the later claimed subject matter." *Ralston Purina Co. v. Far-Mar-Co.*, 772 F.2d 1570, 1575 (Fed. Cir. 1983).

**1. The Specification Shows That Objects Which Have Their References Updated Correspond To Dirtied Memory Section**

In the Final Office Action, the Examiner asserted that the '559 Application lacks sufficient written description for a limitation in the independent claims regarding updating card table

indicators or remembered sets in a *dirtied* memory section. (Final Office Action, p. 4) Appellant respectfully asserts that express support for this limitation does in fact exist in the Specification.

As described in the '559 Application, a memory section becomes "dirtied" when the mutator adds or modifies a reference contained by a card. ('559 Application, pp. 15, 25). When a card is "dirtied" in this manner, the mutator makes a card-table entry to identify the "dirtied" card. ('559 Application, p. 15, lines 28-30). Thus, scanning a "dirtied" memory section, by definition, involves scanning any memory section that includes an *added or modified reference*.

Further, as objects are evacuated to different cars to reclaim memory spaces associated with an empty car (thereby resulting in objects being added to other cars), the card table indicator or remembered set is *updated* to reflect the address (*i.e.*, location) of the evacuated objects. That is, references that point to evacuated objects are updated to reflect the object's new location. ('559 Application, pp. 22, line 22; 23, line 2; 25, lines 11-17, and Figures 12A-12J (depicting the address updates made to each car's remembered set as the train algorithm progresses)).

One of the steps performed to process a remembered set entry is updating the remembered set in a *dirtied* memory area. As depicted in Figure 8A, Step 104, the garbage collector's first step is to scan dirty regions of memory for references to objects in cars. Step 114 of Figure 8A recites "process remembered set entry" and each of the steps performed to process a remembered set entry are shown in Figure 9. Specifically, Step 150 of Figure 9 states that a forwarding pointer is used to update a reference and the remembered set. In addition, Figures 18-19, Steps 330, and Figure 20, Step 350, recite in part "scan cards that have dirty entries in V', updating RS's...", where RS's refers to "remembered sets". Thus, Figures 8A, 9, and 18-20 provide support for the claimed invention with regard to updating remembered sets in *dirtied* memory areas.

Moreover, it is clear that the explanations of Figures 12A-12J apply specifically to *dirtied* memory sections. The '559 Application, at page 22, lines 3-6, recites "[t]he next step is to process the next car, the one whose index is 1.2. Conventionally, this would not occur until some collection cycle after the one during which car 1.1 is collected. For the sake of simplicity we will assume that the mutator has not changed any references into the generation in the interim." Finally, the '559 Application, at page 24, lines 22-25, states "Of course, subsequent collection cycles will not in general proceed, as in the illustrated cycles, without any reference changes by the mutator and without any addition of further objects." Because it is the mutator that "dirties" a memory section, and the descriptions of Figures 12A-12J note that, in practice, cycles will occur with reference to changes by the mutator, it would be clear to one skilled in the art that these figures correspond to *dirtied* memory sections.

In view of the above, Appellant asserts that there is explicit support for the above amendments in the Specification. In the alternative, Appellant asserts that the aforementioned portions of the Specification reasonably convey to the artisan that the inventor had possession of the currently claimed subject matter at the time of filing. Consequently, Appellant respectfully requests that the Board reverse the Examiner's rejection.

**2. The Specification Discloses Storing At Least One Location Of Referencing Objects In The Card Table Indicators**

In the Final Office Action and Advisory Opinion, the Examiner asserts that the '559 Application fails to sufficiently teach that updating card table indicators or remembered sets involves storing at least one location of referencing objects that reference the corresponding objects. (Final Office Action, pp. 4-5; Advisory Action, p. 2). However, Figures 12A-12J of the '559

Application, which describe the train algorithm in detail, do in fact teach storing addresses of referencing objects into remembered sets. For example, Figure 12A shows a remembered set (170) that includes memory locations (*i.e.*, 1.1, 1.2, 1.3, etc.) mapped to objects (*i.e.*, L, F, G, etc.), indicating that the objects are located at the memory locations specified in the remembered set. With respect to Figure 12A, object A is referenced in the '559 Application, at page 21, by object L. Thus, the remembered set (170) contains a reference in object L recorded against car 1.1 and, consequently, a remembered set contains references of corresponding objects. Figures 12B-12J clearly show that, as cars are evacuated and objects are moved, the remembered sets of each car are updated by storing the *location of objects that reference corresponding objects*.

As discussed above, a specification is not required to use the exact language of the claims, but will be found sufficient if it reasonably conveys the claimed invention to one skilled in the art. (See Section VII(A), above). Appellant asserts that the '559 Application, at pages 22-25, Figures 12A-12J and 18-20, and the descriptions of Figures 8A and 9, as described above, would have conveyed to the artisan that the inventor had possession of the subject matter claimed. In view of the above, the Examiner has clearly failed to review the '559 Application as a whole in rejecting the present claims for lack of written description. Accordingly, Appellant respectfully requests that the Board reverse the decision of the Examiner.

**B. Appellant Will Timely File A Petition Addressing Examiner's Objection Under 37 C.F.R. § 1.83(a)**

A rejection of claims is reviewable by the Board of Patent Appeals and Interferences, whereas an objection and requirement to delete new matter is subject to review by petition under 37 C.F.R. § 1.181. MPEP 1002(c)(4). After amendment, the Examiner objected to the drawings under

37 C.F.R. § 1.83(a), asserting that they failed to show every feature of the invention specified in the independent claims. (Final Office Action, pp. 2-3). This objection was reiterated in the Advisory Action. (Advisory Action, p. 2). Pursuant to 37 C.F.R. § 1.181(a), Appellant will address this objection in a timely manner by a petition to the Director of the USPTO.

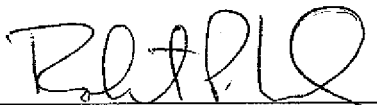
**VII. Conclusion**

In view of the above, the Examiner's assertions clearly do not support the rejection of claims 1-14 and 22-28 under the written description requirement of 35 U.S.C. § 112, first paragraph. Accordingly, a favorable decision from the Board is respectfully requested.

Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 03225/936001).

Dated: December 3, 2007

Respectfully submitted,

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## Claims Appendix

### Claims of Record in the Application

1. A method for tracking and summarizing modified references in a garbage collector operating concurrently with applications, wherein a generation is partitioned in to a group of memory sections and wherein there are card table indicators associated with the group of memory sections storing if an application has written into or dirtied one or more of the memory sections, the method comprising the steps of:
  - finding and atomically interrogating the indicators and finding at least one dirty indicator,
  - resetting the at least one found dirty indicator to indicate not dirty,
  - scanning the at least one dirtied memory section and updating the card table indicators or remembered sets of corresponding objects, wherein updating the card table indicators or remembered sets of corresponding objects comprises storing, in the card table indicators or remembered sets, at least one location of referencing objects that reference the corresponding objects,
  - atomically interrogating the indicators again, and if none are dirty moving on to collect a next scheduled group of memory sections, and
  - if at least one indicator is dirty, preserving the indicators as just interrogated before moving on to another group of memory sections distant from the next scheduled group.
2. The method of claim 1 further comprising the step of preserving information of references to a one younger generation.
3. The method of claim 1 wherein the step of atomic interrogating comprises executing an instruction selected from the groups consisting of a compare-and-swap, a load-store-unsigned-byte, and the pair of instructions, load-locked and store-conditional.
4. The method of claim 1 wherein the step of resetting of the dirty indicators comprises setting the dirty indicator to empty before scanning.



5. The method of claim 1 wherein a dirty indicator contains all zeros and an empty indicator contains all ones.
6. The method of claim 1 wherein each indicator comprises a byte.
7. The method of claim 1 wherein the memory sections are defined as cards and the indicators comprise a card table of bytes that correspond to the memory cards.
8. A computer system for tracking and summarizing modified references in a garbage collector operating concurrently with applications, wherein a generation is partitioned in to a group of memory sections and wherein there are card table indicators associated with the group of memory sections storing if an application has written into or dirtied one or more of the memory sections, the system comprising:
  - means for finding and atomically interrogating the indicators and finding at least one dirty indicator,
  - means for resetting the at least one found dirty indicator to indicate not dirty,
  - means for scanning the at least one dirtied memory section and updating the card table indicators or remembered sets of corresponding objects, wherein updating the card table indicators or remembered sets of corresponding objects comprises storing, in the card table indicators or remembered sets, at least one location of referencing objects that reference the corresponding objects,
  - means for atomically interrogating the indicators again, and if none are dirty moving on to collect a next scheduled group of memory sections, and
  - if at least one indicator is dirty, means for preserving the indicators as just interrogated before moving on to another group of memory sections distant from the next scheduled group.
9. The system of claim 8 further comprising means for preserving information of references to a one younger generation.

10. The system of claim 8 wherein the means for atomically interrogating comprise an instruction selected from the groups consisting of a compare-and-swap, and load-store-unsigned-byte, and the pair of instructions, load-locked and store-conditional.
11. The system of claim 8 wherein the means for resetting the dirty indicators comprise means for setting the dirty indicators to empty before scanning.
12. The system of claim 8 wherein a dirty indicator contains all zeros and an empty indicator contains all ones.
13. The system of claim 8 wherein each indicator comprises a byte.
14. The system of claim 8 wherein the memory sections are defined as cards and the indicators comprise a card table of bytes that correspond to the memory cards.
15. – 21. (Canceled)
22. A computer readable media comprising: the computer readable media containing instructions for execution in a processor for the practice of a method for tracking and summarizing modified references in a garbage collector operating concurrently with applications, wherein a generation is partitioned in to a group of memory sections and wherein there are card table indicators associated with the group of memory sections storing if an application has written into or dirtied one or more of the memory sections, the method comprising the steps of:
  - finding and atomically interrogating the indicators and finding at least one dirty indicator,
  - resetting the at least one found dirty indicator to indicate not dirty,
  - scanning the at least one dirtied memory section and updating the card table indicators or remembered sets of corresponding objects, wherein updating the card table indicators or remembered sets of corresponding objects comprises storing, in the card table indicators or remembered sets, at least one location of referencing objects that reference the corresponding objects,
  - atomically interrogating the indicators again, and if non are dirty moving on to collect a next scheduled group of memory sections, and

if at least one indicator is dirty, preserving the indicators as just interrogated before moving on to another group of memory sections distant from the next scheduled group.

23. The computer readable media of claim 22 further comprising media containing instructions for the practice of the step of preserving information of references from at least one younger generation.
24. The computer readable media of claim 22 wherein the step of atomically interrogating comprises executing an instruction selected from the groups consisting of a compare-and-swap, and load-store-unsigned-byte, and the pair of instructions, load-locked and store-conditional.
25. The computer readable media of claim 22 wherein the step of resetting of the dirty indicators comprises setting the dirty indicators to empty before scanning.
26. The computer readable media of claim 22 wherein a dirty indicator contains all zeros and an empty indicator contains all ones.
27. The computer readable media of claim 22 wherein the indicators comprise a byte.
28. The computer readable media of claim 22 wherein the memory sections are defined as cards and the indicators comprise a card table of bytes that correspond to the memory cards.

**Evidence Appendix**

None.

**Related Proceedings Appendix**

None.